International Standard 3530

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Vacuum technology — Mass-spectrometer-type leak-detector calibration

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

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Belgium	Japan	Spain
Chile	Korea, Rep. of	United Kingdom
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Vacuum technology — Mass-spectrometer-type leak-detector calibration

0 Introduction

This International Standard specifies procedures to be used for calibrating leak detectors of the mass-spectrometer type; that is, for determining a sensitivity figure for such leak detectors. The procedures require the use of a calibrated leak and a standard gas mixture; the preparation and standardization of these are outside the scope of this International Standard. Hereafter, the designation "leak detector" will be used to refer to a detector of the mass-spectrometer type.

A leak detector permits detection of leakage due to mechanical openings, such as pinholes, and of leakage due to permeation, such as occurs through many polymeric materials. Virtual leaks, such as those due to surface desorption, vaporization, and gas pockets, cannot, in general, be detected by a leak detector.

The range of leakage-rate calibration is limited to a specified level since factors that are unimportant for larger leaks may become significant for leak rates that are substantially smaller than 10^{-12} Pa·m^3·s^{-1}.

Objects being tested by a leak detector may be under high vacuum, or, at the other extreme, under pressure greater than atmospheric. The leak-detection techniques will, in general, differ in the two situations. In the first case, the leak detector usually will be operating near its ultimate low pressure; in the second case, the detector is frequently used at or near its maximum operating pressure. Corresponding to these two conditions of operation, two sensitivity terms are defined, "minimum detectable leak rate" and "minimum detectable concentration ratio" (see clause 2).

The two quantities thus defined are related, but in practice it is not feasible to obtain either figure from the other by calculation. Methods are therefore specified for determining both.

This International Standard is one of a series standardizing leak-testing procedures and apparatus, prepared for use in the field of vacuum technology.

Applications fall into the categories : leak tightness, leak-detector calibration, calibration of leaks, gas mixtures, acceptance specifications for leak-detection instruments and general procedures for tightness-proving of vacuum plant.

The above-mentioned requirements will form the subjects of future International Standards.

1 Scope and field of application

This International Standard specifies procedures to be used for the calibration of mass-spectrometer-type leak detectors.

It deals only with leak detectors which have an integral high vacuum system to maintain the sensing element (mass spectrometer tube) at a low pressure. Specifically excepted from treatment are sensing elements without such a vacuum system. It is also to be understood that the procedures are not intended to constitute a complete acceptance test; such tests will be the subject of a future International Standard.

This International Standard concerns the use of helium-4. Nevertheless, the procedures described may be used for other search gases such as argon-40, subject to appropriate precautions.

The application of this International Standard is restricted to leak detectors not capable of detecting leaks smaller than 10^{-12} Pa·m^3·s^{-1}.

Two procedures are outlined, one for determining the minimum detectable leak rate and the other for determining the minimum detectable concentration ratio. These are applicable to the use of the leak detector for high vacuum and for pressures greater than atmospheric, respectively.

2 Definitions

NOTES

1 An ISO glossary of terms used in vacuum technology is not yet available. In view of this, the following list of definitions has been prepared; usage in this International Standard will conform to these definitions.

2 Where a word may be either a noun or a verb, the letters "*n*" or "*v*", in parentheses, indicate which usage is involved.

2.1 Background (or residual signal)

2.1.1 background : In general, the total spurious indication given by the leak detector without injected search gas. Background can originate in either the mass spectrometer tube (see below) or the associated electric and electronic circuitry, or both. (Frequently, the term is used to refer specifically to the indication due to ions other than those produced from injected search gas.)

2.1.2 drift : The relatively slow change in the background. The significant parameter is the maximum drift measured in a specified period of time.

2.1.3 noise : The relatively rapid changes in the background. The significant parameter is the noise measured in a specified period of time.

2.1.4 helium background : Background due to helium released from the walls of the leak detector or leak-detection system.

2.2 Components

2.2.1 inlet line or sample inlet line : The line through which the search gas passes from the object under test to the leak detector.

2.2.2 inlet valve : A valve which is placed at the end of the sample inlet line and adjacent to the leak detector. (See figure 1.) Almost invariably the inlet valve is an integral part of the leak detector.

2.2.3 leak isolation valve : A valve placed between a leak which is to be used for testing the leak detector and the sample inlet line. (See figure 1.)

2.2.4 pump valve : A valve placed between the roughing pump used for evacuating the sample inlet line and that line. (See figure 1.)

2.2.5 vent valve : A valve used to admit air or other gas into an evacuated space so as to increase the pressure therein to atmospheric pressure. (See figure 1.)

2.2.6 backing-off control; zero control : An electrical control, present on most leak detectors, which may be used to shift the output indication of the device. Frequently, the backing-off control is used to return the output indication to zero of the scale, whence the alternative name.

2.2.7 filament : The source of the (thermal) electrons which ionize the gases in the mass spectrometer tube; the filament is located in this tube.

2.2.8 mass spectrometer tube : That element of a leak detector in which the search gas is ionized and detected.

2.3 Search gas

search gas : A gas applied to the outer surface of equipment under leak test and detected, after entry into the equipment through the leak, in a vacuum test, or introduced into the equipment under test and detected after it is emitted from the leak, in a pressure test.

2.4 Leaks

2.4.1 leak (*n*) : In vacuum technology, a hole, porosity, permeable element, or other structure in the wall of an enclosure capable of passing gas from one side of the wall to the other under action of a pressure or concentration difference existing across the wall.

Also, a device which can be used to introduce gas into an evacuated system.

2.4.2 channel leak : A leak which consists of one or more discrete passages that may be ideally treated as long capillaries.

2.4.3 membrane leak : A leak which permits gas flow by permeation of the gas through a non-porous wall. For helium, this wall may be of glass, quartz, or other suitable material.

2.4.4 molecular leak : A leak through which the mass rate of flow is substantially proportional to the reciprocal of the square root of the molecular mass of the flowing gas.

2.4.5 viscous leak : A leak through which the mass rate of flow is substantially proportional to the reciprocal of the viscosity of the flowing gas.

2.4.6 calibrated leak : A leak device which provides a known mass rate of flow for a specific gas under specific conditions.

2.4.7 standard leak : A calibrated leak for which the rate of leakage is known under standard conditions; namely, 23 ± 7 °C, a pressure of 100 kPa ± 5 % at one end of the leak, and a pressure at the other end so low as to have a negligible effect on the leak rate.

2.4.8 virtual leak : The semblance of a leak due to evolution of gas or vapour within a system.

2.5 Leak rates

2.5.1 leak rate : The throughput[1)], in $Pa \cdot m^3 \cdot s^{-1}$, of a specific gas which passes through a leak under specific conditions.

2.5.2 standard air leak rate : The throughput, through a leak, of atmospheric air of dewpoint less than − 25 °C under standard conditions specified as follows : the inlet pressure shall be 100 kPa ± 5 %, the outlet pressure shall be less than 1 kPa, and the temperature shall be 23 ± 7 °C.

1) Differentiated from volume rate of flow, which is also called "pumping speed". Throughput is equivalent to mass rate of flow, when the temperature and molecular mass of the gas are specified.

2.5.3 equivalent standard air leak rate : Short-path leaks having standard air leak rates less than 10^{-7} to 10^{-8} Pa·m³·s⁻¹ are of the molecular type (see 2.4.4). Consequently, helium (relative molecular mass 4) passes through such leaks more rapidly than air (relative molecular mass 29,0), and a given flow rate of helium corresponds to a smaller flow rate of air. In this International Standard, helium flow is measured and the "equivalent standard air leak rate" is taken as $\sqrt{4/29,0} = 0,37$ times the helium leak rate under standard conditions (see 2.5.2).

2.6 Operation of the leak detector

2.6.1 peak (*n*) : The trace showing a maximum on the chart recorder when the leak detector is mass scanned (see below) with gas present, usually the search gas, to which the detector is sensitive.

2.6.2 peak (*v*) : To so set the scanning control (see 2.6.3) of a leak detector that the output due to a given search gas input is maximized. A form of tuning.

2.6.3 scan (*v*) : To vary the accelerating voltage (or other equivalent operating parameter) of a leak detector, particularly across that range of voltage which includes the voltage necessary to produce a search gas peak.

2.6.4 tune (*v*) : In leak-detection technology, to adjust one or more of the controls of a leak detector so that its response to a search gas is maximized. Tuning by means of the scanning control only is called "peaking".

2.6.5 zero (*v*) : To adjust the backing-off or zero control so that the output indication of the leak detector is at the zero of the indicating scale or at some other reference point.

2.7 Relative gas concentration

2.7.1 concentration ratio : Same as mole fraction (2.7.2).

2.7.2 mole fraction : The ratio of the number of atoms (or molecules) of a given constituent of a mixture to the total number of atoms (or molecules) in the mixture. For ideal gases, the mole fraction has the same value as the fraction based on volume; in general, leak detectors are operated in the pressure range where gases behave ideally. Same as concentration ratio.

2.7.3 partial pressure : In a mixture of gases, the partial pressure of a constituent is the product of the total pressure of the mixture and the mole fraction or concentration ratio of the given constituent.

2.8 Sensitivity terms

2.8.1 sensitivity : The sensitivity of a device is the change in output of the device divided by the change in input which caused the response.

2.8.2 minimum detectable signal : An output signal due to incoming search gas which is equal to the sum of the noise and the drift.

2.8.3 minimum detectable leak, minimum detectable leak rate : The smallest leak, as specified by its standard air leak rate, that can be detected unambiguously by a given leak detector (see clause 1). The minimum detectable leak rate depends on a number of factors. Physically, it depends on the volume rate of flow, q_{vi}, of the search gas, measured at the ion source, and minimum partial pressure p_g, of the search gas in the ion source that can be detected, according to the formula

$$\text{minimum detectable leak rate} = p_g \times q_{vi}$$

The minimum detectable leak rate will be calculated as the ratio of the minimum detectable signal and the sensitivity.

NOTE — One of the purposes of this International Standard is to describe practical procedures for determining minimum detectable leak rate, taking into account background, volume rate of flow (pumping speed), and time factor.

2.8.4 minimum detectable concentration ratio : The smallest concentration ratio of a given search gas in an air mixture that can be detected unambiguously by a given leak detector when the mixture is fed to the detector at such a rate as to raise the pressure in the instrument to some optimum high value. In this International Standard, the minimum detectable leak rate is calculated — by a somewhat arbitrary procedure — from observations of the response of the leak detector to a helium-air mixture of known helium concentration ratio (see 3.5).

2.9 Time factors

2.9.1 time constant τ : The time interval required for the output of an instrument or system to change by 1 − 1/e or 63 % of the ultimate (steady-state) output change produced by an abrupt change in input.

2.9.2 response time : The time constant corresponding to a change from a zero or small leak-rate indication, to a positive or larger leak-rate indication.

2.9.3 cleanup time, clearing time : The time constant corresponding to a change from a positive leak-rate indication to a small or zero leak-rate indication.

NOTE — In this International Standard response time and cleanup time are assumed to be equal.

3 Test conditions

3.1 Ambient temperature

Ambient temperature should be 23 ± 7 °C.

3.2 Ambient pressure

Ambient pressure should be 100 kPa ± 5 %. When the deviation from 100 kPa exceeds 5 %, an appropriate correction shall be made, with 5 % tolerable inaccuracy.

3.3 Leaks

3.3.1 General

Two leaks may be required : one with a relatively small leak rate and the other with a relatively large leak rate. The small leak is used for determining minimum detectable leak, the large leak for minimum detectable concentration ratio. The small leak should be calibrated and may be of the channel type or of the membrane type; preferably, the large leak should be capable of being adjusted to vary its leak rate, but this is not essential. The leaks are specified in the following sub-clauses.

3.3.2 Small channel leak

This should have a leak rate such that when helium, at 100 kPa pressure and 23 ± 7 °C, is fed to the leak and thence to the leak detector under test, a deflection is produced on the recorder chart which is not less than 50 times the minimum detectable signal (see 6.1.2). The leak detector should have been adjusted as in 4.3 below. A temperature correction should be specified for the leak, and this correction applied for the difference between the temperature of the leak at the time of use and the temperature at which the leak was calibrated.

3.3.3 Small membrane leak

This should have its own integral, sealed source of helium at not less than 100 kPa pressure. It should leak the helium at a rate which will produce a deflection as specified under small channel leak (see 3.3.2). A temperature correction should be specified for the leak, and this correction applied for the difference between the temperature of the leak at the time of use and the temperature at which the leak was calibrated.

3.3.4 Large (adjustable) leak

This should be a viscous leak, either fixed or so adjusted that when connected to the leak detector with ambient air at the inlet side of the leak, the pressure in the leak detector rises to the optimum high operating pressure (± 50 %) specified by the manufacturer.

3.4 Helium

This should be at least 99 % helium (available from commercial dealers in bottled gases).

3.5 Helium mixture

This should be a helium and air mixture of a known helium concentration ratio such that it produces a deflection of at least 10 times the minimum detectable signal (see 6.1.2) when fed at a pressure of 100 kPa ± 5 % and at a temperature of 23 ± 7 °C to the large (adjustable) leak (see 3.3.4) and thence into the leak detector under test.

Where applicable, atmospheric air may be used as the helium mixture. In either case, the air for the mixture should be obtained from a point at least 2 m outside the walls of the building housing the test equipment. Helium concentration ratio shall be represented by the symbol C_M and should be expressed as a fraction with numerator reduced to unity. Alternatively, the concentration ratio may be expressed in parts of helium per million parts of mixture (parts per million by volume). The concentration ratio of helium in air should be taken arbitrarily as 1/200 000 or 5 parts per million, and this figure should be taken into account when preparing mixtures containing more helium.[1)]

4 Apparatus

4.1 Description

4.1.1 Leak detector

4.1.1.1 The helium leak detector considered here is essentially a gas analyser employing the mass spectrometer principle. In the mass spectrometer tube, a mixture of gases from the object under test is first ionized, then separated into a series of ion beams or groups, each beam or group ideally representing a single species of gas. (Actually, the ions in each beam have the same mass-to-change ratio.) In the helium leak detector, means are provided for "tuning" the instrument so that only the beam due to helium hits an ion collector. (The detector can be retuned, generally, to respond to other gases.) The current produced by the beam is amplified, and its magnitude is a measure of the partial pressure of the helium gas in the incoming sample. It will be assumed that the gas ionization is produced by electrons form a hot filament.

4.1.1.2 Leak detectors consist of a mass spectrometer tube, a high-vacuum system for maintaining the tube under vacuum with a flow of gas sample through or into the tube, voltage supplies, and an ion-current amplifier. The output of the amplifier can be displayed in a number of ways, and almost invariably an indicating electrical meter is one of the means chosen. For the purposes of the present procedures, however, it will be assumed that the output is shown on a chart recorder. Means are provided for reducing the output so that a large range of leak sizes can be detected and measured. In other words, the leak detector can be set at one of a number of different detection levels, hereafter referred to as sensitivity settings.

4.1.1.3 Since the spectrometer tube is required to receive a gas sample from the system under test and also to be kept under vacuum, an inlet line is provided for leading gas from the outside into the spectrometer tube, and this line must have an isolation valve ("inlet valve") in it. Likewise, a pressure-indicating device is also included; the pressure in the spectrometer tube may thus be observed, and prevented from exceeding the maximum specified operating pressure.

1) The latest data indicate 5,24 parts per million of helium in air by volume — GLUECKAUF, E., Compendium of Meteorology, T.F. Malone, ed. (American Meteorological Society, Boston, 1951), pp.3-10.

4.1.2 Chart recorder

4.1.2.1 This should be an instrument of at least 1 h recording time suitable for recording the output of the leak detector under test.

The time constant of the recorder should be small enough to introduce no error in the response time of the leak detector.

4.1.2.2 There should be negligible interaction between the recorder and the output indicating meter; i.e. the velocity of the pointer of either should not generate sufficient electrical signal to affect the indication of the other. If the recorder is connected in parallel with the meter, this interaction will be negligible if each has an input resistance 200 times that of their common voltage source.

4.2 Arrangement for test

4.2.1 The leak detector is connected to an auxiliary system as shown in figure 1. (Frequently, the auxiliary system is included with the leak detector as an integral part thereof.)

4.2.2 The system should contain a minimum of rubber or other polymeric surfaces. Preferably, such surfaces should consist only of the exposed surfaces of an O-ring or O-rings. Accordingly, the "leak isolation valve" shown in figure 1 should preferably be of all-metal construction, but in any case should not act as a significant source of adsorbed helium.

4.3 Preparation for test

4.3.1 The leak detector should have been connected to a power source conforming in voltage, frequency, and regulation to the manufacturer's specifications.

4.3.2 The leak detector should have been "warmed up", as specified by the manufacturer, prior to all test procedures.

4.3.3 The leak detector under test should have been adjusted for optimum detection of helium in the manner specified by the manufacturer.

4.3.4 If the vacuum system of the leak detector is such as to permit adjustment of volume rate of flow (pumping speed), the selected rate should not be varied during the test.

4.3.5 The recorder should be adjusted so that full scale on the recorder corresponds to full scale of the leak detector output meter when the leak detector is at its most sensitive detection setting and so that zero of the recorder corresponds to zero of the output meter.

5 Test procedure

5.1 General

In order to determine the minimum detectable leak and/or the minimum detectable concentration ratio it is necessary to define the operation of the leak detector near the limit of its sensitivity. The initial stage is therefore concerned with the determination of the minimum detectable signal in terms of drift and noise. This is followed by the determination of the overall sensitivity of the instrument with reference to a calibrated leak.

5.2 Minimum detectable leak

5.2.1 Drift and noise determination

5.2.1.1 Connect the output of the leak detector to the recorder, the leak detector being at its maximum sensitivity setting and the inlet valve closed. See also 4.3.

5.2.1.2 Adjust the leak detector backing-off (or zero) control so that the recorder reading is approximately 50 % of full scale, the filament being on.

5.2.1.3 Record the output for 20 min or until the output has reached full scale, for positive drift, or zero, for negative drift.

5.2.1.4 Draw a series of line segments intersecting the curve recorded in 5.2.1.3, the lines to be drawn at 1 min intervals at right angles to the time axis (abscissa) of the chart, and to commence at the point where the procedure of 5.2.1.3 is started. The lines so drawn will be called the "1 min lines".

5.2.1.5 Treat the drift and noise curves as in 6.1.1.

Draw straight-line approximations for each segment of the curve between adjacent 1 min lines.

5.2.2 Spurious signal determination

5.2.2.1 This determination requires the use of the small calibrated leak. If the calibrated leak has its own integral valve, and the leak and valve are of all-metal construction (except perhaps for the membrane in a membrane-type leak), sub-clause 5.2.2 may be omitted from the procedure.

5.2.2.2 Connect a metal plug to the leak detector as indicated on the left side of figure 1.

5.2.2.3 Zero the output, with the filament on.

5.2.2.4 Open the leak isolation valve.

5.2.2.5 Open the pump valve.

NOTE — For its safety, the filament of the mass spectrometer tube may be turned off at this point.

5.2.2.6 When the atmospheric air present between the plug and the inlet valve has been evacuated, close the pump valve.

5.2.2.7 Open the inlet valve promptly, but gradually. Allow the pressure in the leak detector to reach a steady value, showing no observable change in 1 min.

5.2.2.8 Turn on the filament of the mass spectrometer tube if it is not on.

5.2.2.9 When the output has reached a steady value, but in any case not longer than 3 min after initiating the procedure in 5.2.2.7, note the output reading. If the leak detector has been set at reduced sensitivity, the reading should be converted to equivalent scale divisions for full-sensitivity setting.

5.2.2.10 Close the leak isolation valve as rapidly as feasible, and 10 s thereafter, note the output reading. As in 5.2.2.9, convert the reading if necessary.

5.2.2.11 Close the inlet valve.

5.2.2.12 Open the vent valve.

5.2.2.13 Remove only the plug from the inlet line; all connections are to remain in place.

5.2.2.14 Close the vent valve.

5.2.3 Sensitivity determination

5.2.3.1 Put the small calibrated leak in place of the plug removed in 5.2.2.13 above, inserting the leak the same distance into the connection as the plug had been.

5.2.3.2 Zero the output with the filament on.

5.2.3.3 Open the leak isolation valve.

5.2.3.4 Open the pump valve.

5.2.3.5 Apply helium at 100 kPa ± 5 % pressure to the leak. If the leak has its own supply of helium, omit this step.

NOTE — The filament of the mass spectrometer tube may be turned off before 5.2.3.6.

5.2.3.6 When the atmospheric air present between the calibrated leak and the leak detector has been evacuated, close the pump valve.

5.2.3.7 Open the inlet valve promptly after initiating the procedure in 5.2.3.6. Allow the pressure in the leak detector to reach a steady value, showing no observable change in 1 min.

5.2.3.8 Turn on the filament of the mass spectrometer tube if it is not on.

5.2.3.9 At this point it may be necessary to change the sensitivity setting. When the output signal has reached a steady value, showing a change in 1 min which is not greater than the drift (as corrected for the sensitivity setting), note the output reading in scale divisions. If the leak detector has been set at reduced sensitivity, the reading should be converted to the equivalent scale divisions for full-sensitivity setting.

5.2.3.10 Immediately after the preceding step, start the stopwatch and simultaneously close the leak isolation valve as rapidly as practical. Alternatively, the recorder chart may be marked to indicate the beginning of the timed period and the leak isolation valve then closed rapidly.

5.2.3.11 In order to determine the cleanup time (see 2.9), it is necessary to observe the output continuously and stop the stopwatch when the reading has decreased to 37 % of the reading observed in 5.2.3.9 above. Note the reading of the stopwatch. Alternatively, examine the recorder chart to determine the time required for the specified decrease in output.

NOTE — Should cleanup time be a function of sensitivity setting, the time observed should be corrected to the cleanup time at full sensitivity setting, if any other setting was used.

5.2.3.12 One minute after closing the leak valve (5.2.3.10), read and note the output. Correct for sensitivity setting as in 5.2.3.9.

5.3 Minimum detectable concentration ratio

5.3.1 General

5.3.1.1 The determination of minimum detectable concentration ratio requires means within the leak detector under test for scanning the helium peak. This means is generally an adjustment of the accelerating voltage, and it will be assumed that this is the case (see 2.6.3). When leak-detector output (scale divisions) is plotted against accelerating voltage, a curve is obtained, whose general features are illustrated by the solid line in figure 2 a). The rise in the curve to a peak at B is due to the presence of helium. The faired curve indicated by a broken line is due to a varying background signal contributed by other ions in the absence of helium. With helium present, and in the absence of background, the curve obtained would be symmetrical, falling off asymptotically to zero on either side of the peak voltage. The curve shown in figure 2 a) is very nearly a direct superposition of the background curve and the symmetrical pure-helium curve.

5.3.1.2 It should be noted that as the voltage is varied from the left side of the graph to the right, the output first decreases, then increases, and finally decreases again. This reversal in direction, indicating the presence of helium, is very easily detected when the scan is being observed visually on a meter. As the helium input is progressively reduced, the reversal becomes smaller until eventually a curve, such as is shown by the solid line in figure 2 b), is obtained. Under these conditions the output never reverses; it remains constant for a very short voltage interval. Such a condition will barely be detected by the usual visual observations. In the absence of noise and drift, the concentration ratio of helium which produces this condition determines the minimum detectable concentration ratio.

5.3.1.3 Helium background gives rise to a trace similar to that of figure 2 a). The total situation is illustrated by figure 2 c). The first (lowest) solid-line curve represents the minimum detectable concentration ratio. The next curve represents the helium output due to background in the absence of injected helium. The third curve represents the output due to incoming helium plus helium background.

5.3.1.4 In the following determination the helium background is called the spurious signal.

5.3.1.5 Under practical conditions it is not possible to make a rigidly correct determination of the minimum detectable concentration ratio as defined above. In the following, somewhat arbitrary determinations are used for calculating a sensitivity figure. The minimum detectable concentration ratio so obtained is one that is reasonable in the light of practical experience.

5.3.2 Drift and noise determination

5.3.2.1 Connect the output of the leak detector to the recorder, the leak detector being at its maximum sensitivity setting, the inlet valve closed, and the filament off. See 4.3.

5.3.2.2 Connect the leak detector to an auxiliary system as shown in figure 1 and further specified in 4.2.1.

5.3.2.3 Connect the large leak (calibrated or adjustable) to the leak detector. See figure 1.

5.3.2.4 Feed atmospheric air or a helium mixture (see 3.5), at 100 kPa ± 5 %, to the leak. In case atmospheric air is used, the feed line should not of itself act as a source of helium and preferably should be of all-metal construction.

5.3.2.5 Open the leak isolation valve.

5.3.2.6 Open the pump valve.

5.3.2.7 When the atmospheric air present between the leak and the inlet valve has been evacuated, open the inlet valve.

5.3.2.8 Close the pump valve.

5.3.2.9 If an adjustable leak is being used, adjust it to bring the pressure in the leak detector to its optimum value as specified in 3.3.4.

5.3.2.10 Turn on the filament and adjust the sensitivity control, if necessary, to the highest sensitivity setting that will result in an on-scale recorder indication.

5.3.2.11 Adjust the backing-off (or zero) control so that the recorder reading is as near to 50 % of full scale as possible.

5.3.2.12 Record the output for 20 min or until the output has reached full scale, for positive drift, or zero for negative drift. This record is called the drift curve.

5.3.2.13 Set the sensitivity control on full-sensitivity setting. If the indication is off-scale, bring it to mid-scale by means of the backing-off (or zero) control. If this is not possible, set the sensitivity control to the highest sensitivity setting that will produce an on-scale indication. Bring the indication to mid-scale by means of the backing-off (or zero) control.

5.3.2.14 Record the output for 20 min or until the output is off-scale. This record is called the noise curve.

5.3.2.15 Treat the drift and noise curves as in 6.1.1.

5.3.3 Spurious signal determination

5.3.3.1 With the equipment as it was at the end of 5.3.2.13, close the leak isolation valve.

5.3.3.2 Set the leak detector for the greatest sensitivity that will give on-scale readings. (If necessary, readjust the scanning control for helium peak.)

5.3.3.3 When the output signal has reached a steady value, showing no observable change in 1 min, scan the helium peak as specified for the instrument. The output will, in general, produce a curve of the form shown in figure 2 a). The curve is faired, as is also shown in the figure by the broken line.

5.3.3.4 Take the ordinate AB as a measure of the helium background, B being located at the maximum of the curve and A directly below B.

5.3.3.5 If AB is not zero, repeat the scanning at 15 min intervals until AB has become zero or has not changed over a 30 min period.

5.3.4 Sensitivity determination

5.3.4.1 Close the inlet valve.

5.3.4.2 Open the leak isolation valve.

5.3.4.3 Open the pump valve.

NOTE — The filament may be turned off at this point.

5.3.4.4 When the air present between the leak and the inlet valve has been evacuated, open the inlet valve.

5.3.4.5 Close the pump valve.

5.3.4.6 When the pressure in the leak detector has reached a steady value, showing no change in 1 min, turn on the filament if it is not on.

5.3.4.7 When the output signal has reached a steady value, showing no change in 1 min which is greater than the drift (see 6.2.1.1), scan the helium peak as specified for the instrument. The output will, in general, produce a curve of the form shown in figure 2 a). The curve is faired, as is also shown in figure 2 a) by the broken line.